CATALOG D-20

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Design Division

BAUSCH & LOMB SPECTROGRAPHIC EQUIPMENT

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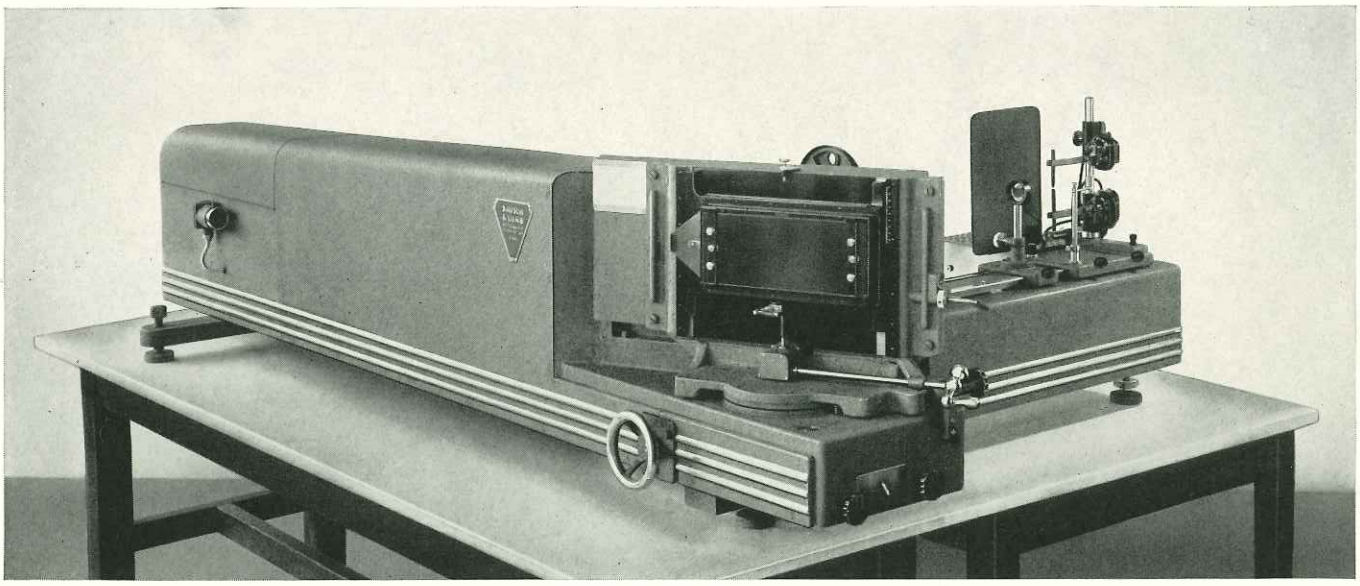


Large Littrow Spectrograph and Illuminating Unit

LARGE LITTROW SPECTROGRAPH

With Semi-Automatic Controls Grouped for Convenience and Speed of Operation.
High Dispersion—Long Range Spectrum.

THE Bausch & Lomb Large Littrow Spectrograph is an instrument that will satisfy the most exacting needs of the laboratory which must be equipped to handle any spectro-analytical problem that may arise. With it, even the most complex spectra are effectively resolved and dispersed. This permits accurate work, both qualitative and quantitative, with alloy steels, tungsten carbide alloys, stellite and other materials yielding spectra in which the lines are so crowded together that an instrument of smaller linear dispersion cannot be used satisfactorily. At the same time it is admirably suited to the analysis of materials whose spectra are relatively simple.

The Littrow, auto-collimating type, is used because of the saving in space that results from this form of construction. At the same time, this construction requires but half the amount of large optical quartz that would be needed with other types, with a corresponding saving in the price of the instrument.

The quality of the line imagery throughout the spectrum is exceptionally good, the lines being sharp and clean cut to the very ends of the plates. Internal reflections and stray light have been reduced to a minimum, with the result that the plates are completely free from fog.

The primary considerations in the design and construction of this spectrograph have been:

1. The highest perfection of optical performance.
2. Extremely sturdy construction, to insure rigidity and permanent alignment and adjustment.
3. Convenience of operation.

The Quartz Prism System

The quartz prism is 57mm high with a refraction face 95mm long. The reflecting coating on the back surface is evaporated aluminum. The lens is 70mm in diameter and 1827mm focal length. By careful adjustment this lens has been so located that there is no difficulty with reflected light and the central part of the lens is not blocked off. Two stops are provided for reducing the aperture when desired. This reduction, however, is all in the vertical dimension, so as not to decrease the effective length of the prism. In this way the full resolving power is maintained.

The Focusing System

The dispersed spectrum, from wave lengths 2100Å to 8000Å, has a total length of about 700mm and can be covered satisfactorily on three photographic plates, ten inches long. One is not, however, limited to these three positions. The adjustments are so arranged that seven other intermediate positions are also available, permitting any one of ten sections, each ten inches long, to be photographed. Positions are read from the illuminated scale on the side of the instrument. These sections are equally spaced throughout the spectrum, which makes it possible to bring any desired spectrum line near to the center of the plate. The co-ordination between focus and prism rotation is secured by means of a cam, which causes the prism to rotate as it is moved forward or back in focusing. Ten fine-pitch micrometer screws are inserted in this cam at suitable intervals and each of these is accurately adjusted so that, when

the screw carried on the arm which rotates the prism table bears on the end of a given screw, the portion of the spectrum is brought on the plate which is in focus with that position of the focusing carriage.

The Glass Optical System

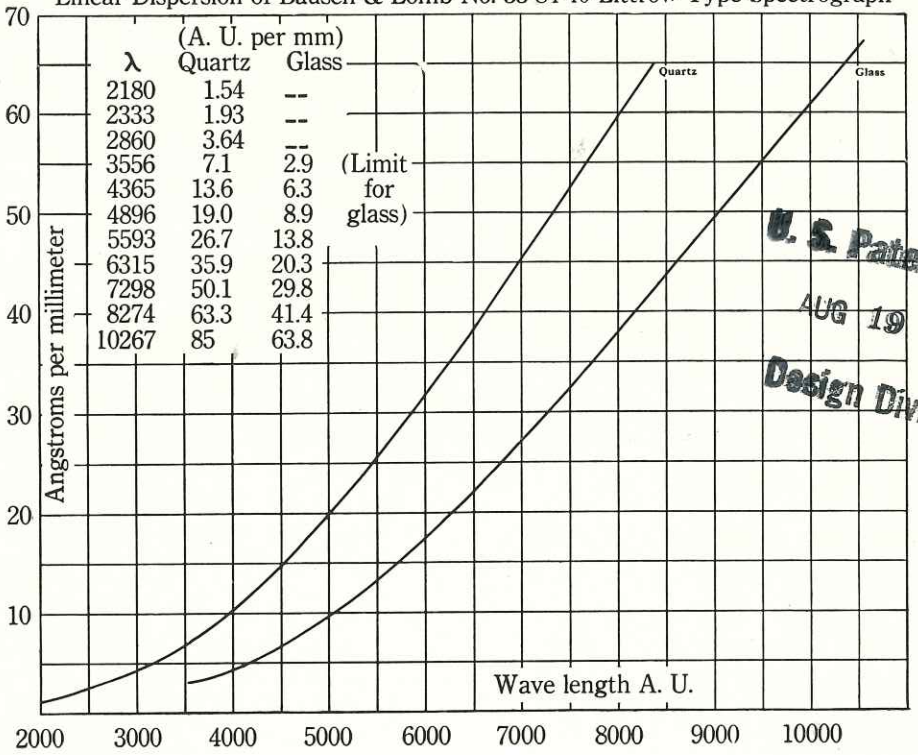
For those whose work involves much use of the long wave length portion of the spectrum, the small dispersion of quartz in this range may prove a handicap, making it difficult to measure wave lengths with the necessary precision. We, therefore, offer for use with this spectrograph a quickly replaceable set of optical parts, made of flint glass of refractive index 1.617. This prism and lens combination is mounted on a separate metal table which may be substituted for the one carrying the quartz system, the change requiring but a few minutes. Location pins insure accurate placing of the tables and the optical parts are so adjusted that the focusing is done in exactly the same way as with the quartz optics. A second cam serves to co-ordinate focus and prism rotation at seven points in the range transmitted by the glass prism.

With the glass system, the range of the spectrograph is from about 3550 Å to 10,000 Å, this portion of the spectrum covering two of the ten-inch plates. The linear dispersion of this system is about twice that of the quartz at the same wave lengths.

The wave length ranges specified for both glass and quartz systems are approximate and may vary slightly from one instrument to another. They cover the requirements of most workers and include all wave lengths that can be photographed readily without highly specialized photographic material and technique. Upon special order, the ranges can be somewhat extended to include longer wave lengths with the glass system, and shorter wave lengths with the

Linear Dispersion of Bausch & Lomb No. 33-84-40 Littrow Type Spectrograph

λ	(A. U. per mm) Quartz	Glass	
2180	1.54	--	
2333	1.93	--	
2860	3.64	--	
3556	7.1	2.9	(Limit
4365	13.6	6.3	for
4896	19.0	8.9	glass)
5593	26.7	13.8	
6315	35.9	20.3	
7298	50.1	29.8	
8274	63.3	41.4	
10267	85	63.8	



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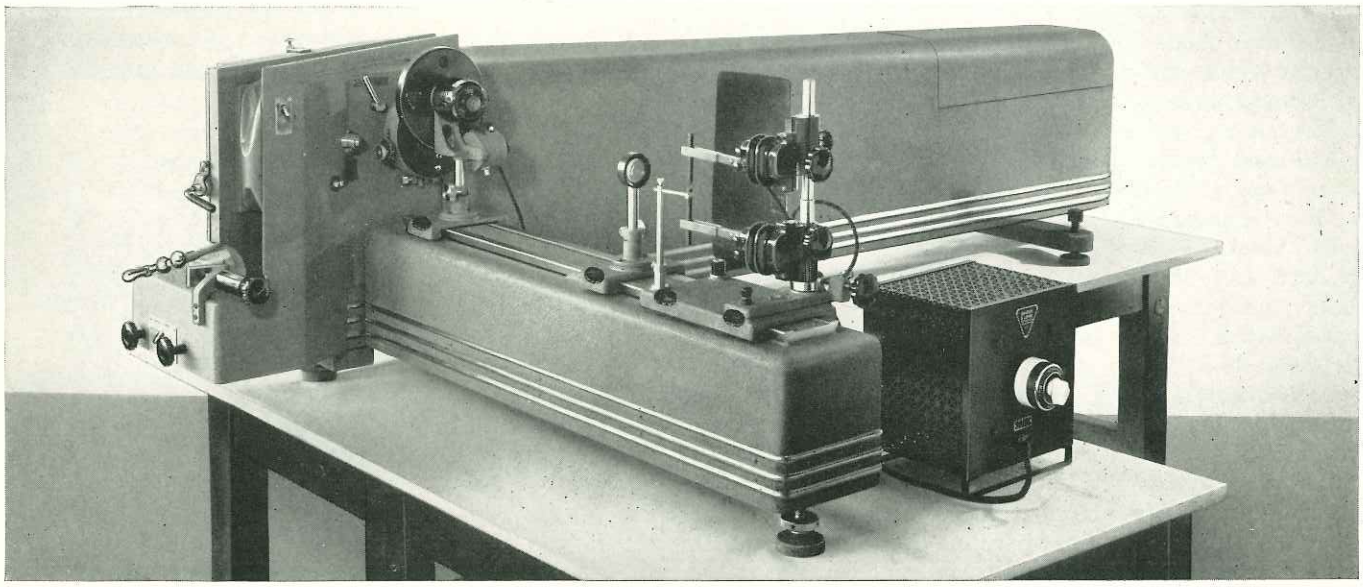
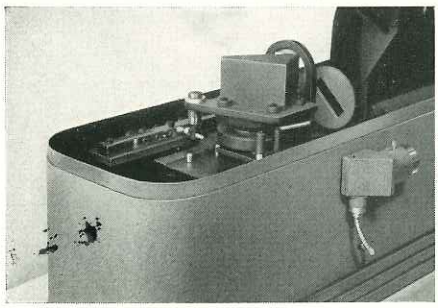
Large Littrow Spectrograph and No. 33-84-49-13 Illuminating Unit





Large Littrow Spectrograph open to show Focusing Mechanism (Showing Quartz Optical System with Cam)

quartz system. Extra charges for such extensions will be quoted upon receipt of information as to the ranges required.

Sturdy Body Construction

The construction is extremely heavy to secure perfect rigidity and complete freedom from effects of vibration, and to insure permanence of alignment and adjustment. The aim has been to provide a reliable working tool, accurate enough for the most precise work, and substantial enough to be ready for the most severe routine service, without the necessity for frequent readjustments.

The enclosing case is of sheet metal and unusually large, with hinged cover for access to prism assembly. This large size has been found to be the most effective means for providing for the deflection and absorption of stray reflected light, insuring clean plates, free from the fog and light streaks which are sometimes found with instruments of the Littrow type.

The base is a heavy section hot-rolled steel channel which has been found superior to the usual cast iron for instruments of this size, since hot-rolled steel is less liable to changes in form and dimensions with time than is cast iron. The focusing carriage travels on two heavy rails of stainless steel, being supported on two Vee notches and a plane, insuring perfect stability and accurate motion. The focusing motion is imparted to the carriage through a bronze wire cable actuated by a hand wheel placed at the operating end. Heavy spring tension on the cable insures smooth operation without backlash.

A particularly advantageous feature is the design of the instrument back. In order to permit the plate to meet the focal curve accurately in any part of the spectrum, it is necessary that its angle of inclination to the optical axis be susceptible of adjustment. Instead of the usual method of hanging this back on a hinge at one end, the back of the B&L Spectrograph is rigidly supported on a large turret bearing centered directly below the center of the photographic plate. Two things are accomplished by this construction. The support is perfectly stable and puts no strain on the supporting structure which might tend to twist and distort the instrument. Secondly, the rotation of the back does not alter the distance of the plate center from the lens. Consequently, once the center line is in focus, it is a simple matter to rotate the back by means of a micrometer screw until the two ends are also in focus. The center remains in focus throughout this adjustment.

Slit Assembly

As standard equipment, the Littrow Spectrographs are equipped with a newly designed fixed slit assembly. The adjustable type slit, listed on page 9 as No. 33-84-14, will be supplied on special order as a substitute for the fixed slit equipment without extra charge.

The body of the slit assembly is attached to the spectrograph and serves as a holder for one removable fixed slit and the usual Hartmann diaphragm. Attached to it is a rotatable holder for slit cover lenses and moderating filters.

The individual fixed slits consist of stainless steel jaws held firmly in a sturdy metal frame with two beveled edges to fit into the ways at the top of the holder. The design permits setting the jaws to any slit width by means of headless screws driving against V notches. Four widths of slit are supplied, 10, 20, 30 and 50 microns. Other widths can be provided on special order. Users can change slit width with the aid of a measuring microscope. A handle is provided for easy insertion of the slit in the holder. The slit width is engraved on this part. For storage a leatherette case is provided to hold three slits.

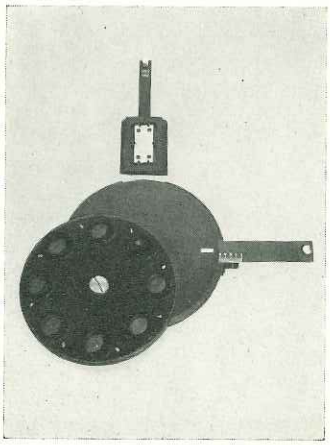
The lens holder is designed to bring before the slit any one of eight openings. The standard quartz slit cover lens is located in one. Lenses of different focal lengths, moderating filters, step diaphragms, and similar devices can be inserted into these apertures and are held in place by a knurled head threaded retainer ring. A shield between the lens holder and the slit holder protects the rear surface of the lenses and filters against dust, to prolong the life of evaporated film surfaces.

For use on Bausch & Lomb Spectrographs already in service the fixed slit holder and fixed slits are listed separately on page 9. Installation and adjustment in place of the adjustable type slit are simple. When sold individually, each fixed slit unit is supplied in a plastic envelope.

Centralized Controls

The spectrograph is extremely convenient to use. All adjustments are made by the operator from his position at the plate-holder end. The rotation of the main prism to bring different portions of the spectrum into the field is so coupled with the focusing motion that the two are in proper relation to each other for each of the ten positions. Two motions only are required in changing from one wave-length range to an-

Fixed Slit Holder



other. The focusing wheel is turned until an index line indicates the required position on an illuminated scale attached to the focusing carriage and is easily seen from the operator's position. This adjustment sets both focus and prism rotation. The back is then rotated to meet the focal curve by turning a micrometer head within easy reach, until the predetermined corresponding reading is reached. This micrometer is direct reading with number wheels, reading to tenths of a turn. Both adjustments may be locked, although both are sufficiently positive to remain in position without this precaution.

Plate Holder Design

The metal plate holder permits the use of either 4″ x 10″ or 2″ x 10″ plates, either size being accurately held to the proper curvature to insure sharp focus throughout the spectrum. The plate curvature has been reduced to a minimum by careful design of the optical system. The plate holder may be moved vertically by means of a crank and screw. A well designed split nut permits quick raising or lowering, independent of the screw.

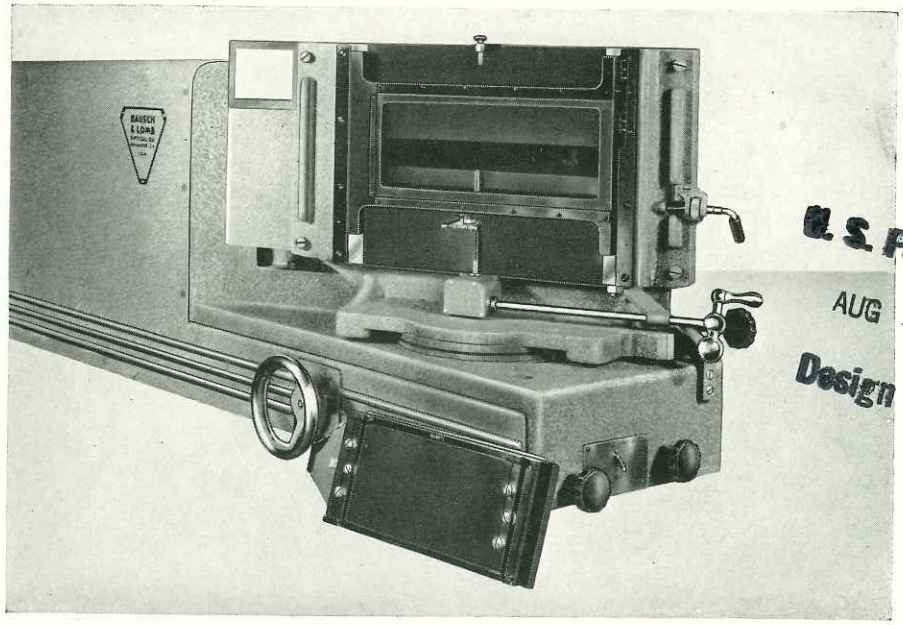
Reference Scale

Provision is made for printing a scale of millimeters on the spectrum plates, a convenient means of reference to calibration curves. A negative of the scale is carried on an internal rod actuated by a handle with which it may be brought up into contact with the plate. It is then illuminated momentarily by a small lamp on closing a switch.

A dry cell supplies the current for both the focusing scale lamp and internal millimeter scale lamp.

Specifications

Focal Length of Objective (5893Å) 1827mm
Aperture of Objective 70mm
Height of Prism 57mm
Length of Refracting Face . 95mm
Wave-Length Range (quartz system) 2100-8000Å
Wave-Length Range (glass system) 3550-10000Å
Total Length of Spectrum (quartz system) approx. . 700mm
Total Length of Spectrum (glass system) approx. . . 400mm
Linear Dispersion (See page 3)
Speed (5893A) *f*/26
Plate Size . . . . 2″ x 10″ and 4″ x 10″
Over-all Length of Spectrograph . . . . . 8′ 0″
Over-all Width . . . . . 2′ 0″
Over-all Height . . . . . 2′ 0″
Width with Illuminating System Attached . . . . . 4′ 8″
Weight . . . . . 600 lbs.
Shipping weight, packed . . . . . 900 lbs.



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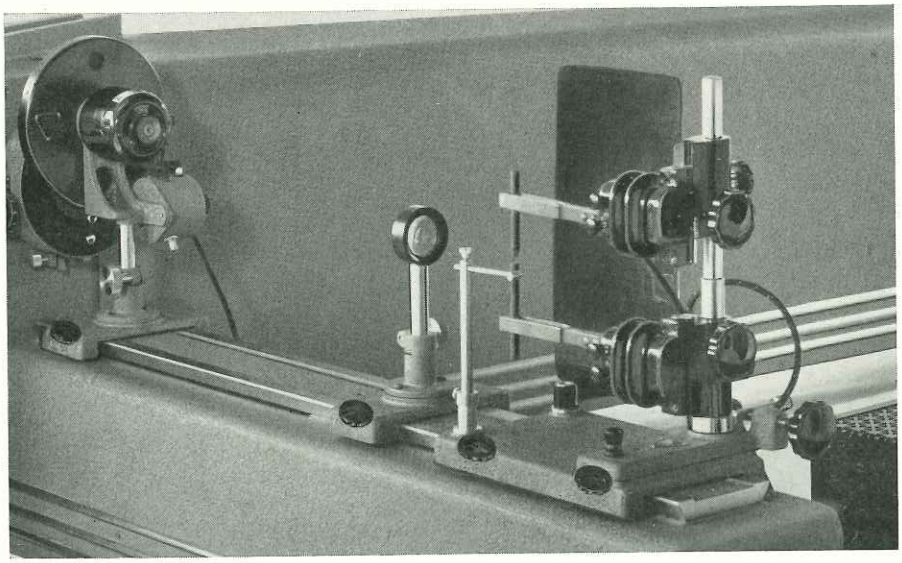
Large Littrow Spectrograph, showing plate holder removed

Specifications	*Catalog Number*	
Littrow Spectrograph only, with quartz optics, slit holder and rotatable lens holder, fixed slits 10, 20 and 30 micron widths in storage case, internal millimeter reference scale printer, and one plate holder No. 33-84-44 for 4″ x 10″ and 2″ x 10″, as described . . . . . (Select Illuminating Unit from listing on Page 13)	33-84-40-01	
Glass Optical System, assembled on table interchangeable with that carrying the quartz system, including cam for co-ordinating focus with prism rotation and one No. 33-84-46 plate holder with proper plate curvature—all in accurate adjustment, when ordered with new Littrow Spectrograph . . . . . (Glass optical system must be ordered at the same time as the spectrograph with which it is to be used)	33-84-41-01	
Accessories and Replacement Parts (also see listings on Page 9)		
Plate Holder, 4″ x 10″, with adapter for 2″ x 10″ plates, for quartz optical system	33-84-44	
Plate Holder, 4″ x 10″, with adapter for 2″ x 10″ plates, for glass optical system	33-84-46	
Scale Negative, for Printer	27676-9001 ND	
Lamp 1.3V-0.6A, for Reference Scale Printer	33-33-89	
Lamp 1.3V-0.6A, for Focusing Scale	33-33-89	



Complete Illuminating Attachment No. 33-84-49-13, Large Littrow Spectrograph

ILLUMINATING UNITS AND ACCESSORIES

Illuminating Units 33-84-49-

Two arrangements of illuminating systems are offered which fit the Bausch & Lomb Spectrographs, differing only as to the type of arc and spark stand included.

The base is of form and finish harmonizing with those of the spectrograph. On it is mounted a dove-tail slide on which the various parts of the illuminating system are clamped by means of supports which may be moved along the length of the slide to secure the desired type of illumination. The base is provided with machined bosses at the end, which bear against corresponding bosses on the spectrograph base to which it is attached by cap-screws.

With Open Arc and Spark Stand

The arc and spark stand is carried on a base which fits on the dove-tail slide and may be clamped at any point along the length. A single upright rod carries both of the electrode supports which may be rotated about its axis by means of a knob and screw to secure lateral adjustment of the electrode position. The electrode supports are vertically adjustable by means of rack and pinion mounts and may be swung to any position about the axis of the upright rod.

The electrode holders are of the spring fork type used on previous units and are mounted in corrugated porcelain insulators between them and the rack and pinion supports. These insulators are capable of withstanding spark potentials of 15,000 volts. Electrical connections are made to metal blocks inserted in the insulators. These blocks also serve as seats for the electrode holders. Thus the electrode holders are the only parts that carry the current; the rack and pinion supports and upright rod are electrically "dead." As a further precaution, a binding post is provided on the base for a ground wire to dissipate any charge that may accumulate when using the high tension spark.

The eye shield on the arc and spark stand is a large plate of dark plastic material.

An index pointer is supplied, on a vertical rod, to indicate height and separation of the electrode gap. It may be swung to the side after electrode adjustments have been made.

The eye shield and index pointer supports are interchangeable so that they can be located on either side of the stand.

A quartz condensing lens is carried in a mount which fits on the dove-tail slide and provides the means for focusing the light from the source either on the slit of the spectrograph or on the collimator, depending on the type of illumination preferred.

Accessories

For use with the arc, a rheostat is included. It provides three current adjustments, for 2¼, 4½ and 9 amperes, the change from one to another being made with a three-point switch mounted at one end of the casing. These ranges have been found to cover most of the needs of analytical spectrography. In ordering state the voltage of the power line to be used (230 volt preferred, see page 9). Direct current is necessary for the arc, as it is impossible to maintain a satisfactory arc between graphite or metallic electrodes with alternating current at ordinary line voltages.

In order to permit making exposures of sufficient length to insure complete volatilization of refractory samples without over-exposing the photographic plate, a rotating sector disc is provided with this unit. This disc is mounted on the shaft of a small motor which, in turn, is mounted on a support similar to that which carries the condensing lens. It may be attached to the dove-tail slide and locked firmly in position. The disc is adjustable from zero to 180° opening with graduations indicating fractional openings. A rheostat is connected in series with the motor to keep its speed down to a point that will avoid vibration. The motor is of the universal type for either alternating or direct current of 115 volts. If a 115 volt line is not available, a plug type of resistance can be supplied to permit use of this motor on lines of higher voltage.

With Safety Arc and Spark Stand

The Bausch & Lomb Safety Arc and Spark Stand is a compact unit for arcing and sparking various types of samples. It is suitable for general spectrographic work in in-

dustrial, research, and college laboratories. The outstanding features are (1) ease of changing electrodes; (2) protection to the operator from either harmful radiation or accidental shorting while current is passing through the stand; (3) ease of alignment; (4) ease of cleaning.

The Safety Arc and Spark Stand is designed for clamping to the present style wide dove-tail slides on B&L illuminating unit attachments for the Large Littrow Spectrograph.

Protection

All the current carrying units are enclosed in a large cylindrical chamber thoroughly insulated, and are spaced to avoid arcing between live parts and internal projections. They are accessible only after opening a door which comprises one half of the circumference of the cylinder. On opening of this door, a micro switch mounted within the housing automatically breaks the electric circuit.

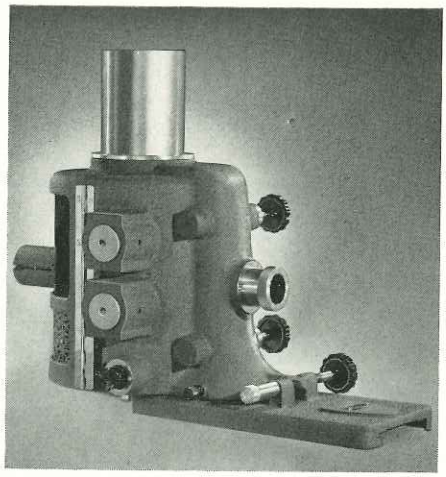
The housing and connected external parts are all grounded through a binding post connection at the base of the housing, to provide additional protection.

For eye protection, the arc and spark can be observed through a blue plastic shield which forms the upper half of the door. Ventilation is provided for removal of obnoxious fumes.

Sample Holder

Each electrode is held in a sturdy V-block by pressure from a broad stainless steel spring clip. It accommodates the usual size carbons or metal pins. A table of the Petrey type is included for clamping in the upper electrode holder. This is designed for holding flat samples or bars as used in the point to plane technique. These can be up to ¾″ thickness and 6″ length or 3″ in diameter. The electrode holder design affords quick and easy change of samples.

The complete Electrode Holder Assembly consists of the pinch clamp V-block sample holder attached to a heavy duty porcelain unit that will insulate against currents up to 40,000 volts and 20



Safety Arc and Spark Stand

amperes safely, and a rack and pinion device. These two assemblies are mounted on a single plate which in turn fastens to the cylinder wall. The electrode holders are permanently aligned but easily removed from the porcelain insulator by loosening a thumb screw. This facilitates cleaning and permits easy replacement in case new parts are ever required.

Each Electrode Holder Assembly is actuated independently and the gap width controlled with an external plastic knob and shaft assembly. Hand screws are provided for locking the shaft.

The maximum rack movement is 2¼″, providing for ample gap width. An adjustable swing-out arm aids in manually setting the gap on the optical axis. When the door is closed, this arm is automatically pushed back against the housing wall to avoid shorting of the current from the electrode holder parts. The tip of this arm assembly can be used as a gap width gage. It is removable for substitution of gages of other thicknesses which an operator might wish to supply.

Circuits

The power lines feeding the analytical gap enter through ports in the stationary part of the housing. Cables of 1″ or ⅜″ can be used with the equipment supplied. Reducing adapters for other sizes smaller than ⅞″ are available on special order.

When used with simple low voltage power circuits, the line cord provided is plugged into the power line, and the plug supplied in the socket in the base of the housing is wired to the rheostat or spark generator which in turn is connected with the analytical gap. Thus, the power flows through the safety switch in the housing and is automatically cut off when the door is opened. For use with high powered source excitation equipment, the line cord plug supplied is shorted and the switch circuit connected to the interlock circuit on the power source unit.

Alignment Facilities

For alignment purposes, in addition to the vertical adjustment provided for the analytical gap, the housing can be rotated with the centering device attached to the base. A focusable lens mounted in the door frame projects an image of the arc or spark so that wandering during operation can be easily detected and corrected. The minimum screen distance is three feet.

Optical System

A single quartz condenser lens is provided in a focusing mount in the main housing. The distance between the electrode gap and this lens has been made as great as possible to reduce pitting to a minimum. It is removable when desired, as in quantitative work.

Interior Finish

The finish of the interior of the cylindrical housing is heat resisting aluminum enamel which provides a smooth finish aiding in the removal of accumulated deposits that might cause contamination of samples or short circuits. The aluminum color provides a high degree of contrast and illumination, to aid in seeing internal parts when adjustments are necessary.

Door

The large door opens to the right of the operator making it convenient for use with the B&L Littrow Spectrograph where the illuminating unit attachment is to the right of the centralized controls at the plate

holder end. The hinge is of the sturdy piano case type. The upper half of the door contains a dark blue plastic window for eye protection while viewing the arc or spark in operation. The arc projection lens is located in the metal strip in the center of this door.

Ventilation

Ventilation is provided by air admitted through the large grill work area in the lower half of the door and passing through the interior of the housing to the 4″ diameter chimney. An open type hood directly over the arc and spark stand is recommended. It should be large enough to receive fumes when the arc and spark stand is located at any position on the illuminating unit slide. A flexible pipe may be used with a low suction fan.

External Finish

The outside finish is grey crackle, matching Bausch & Lomb Spectrographs and their illuminating units. Flutes and other dirt catching contours have been avoided.

Base Clamp

The base of the Safety Arc and Spark Stand is channeled to fit the 4″ width dove-tail slide used on illuminating units for current Bausch & Lomb Spectrographs. The stand is offered separately or as part of the standard illuminating attachments in the No. 33-84-27 and No. 33-84-49 series.

Step Sector Disc

To provide an accurate basis for quantitative analysis, this disc is offered as an optional accessory, interchangeable with the adjustable sector on the motor mount supplied as a part of the illuminating unit. It provides a means for varying the exposure over the length of the spectrograph slit in a series of eight steps. The periphery of the disc has two series of seven steps each. The angular lengths vary from one step to the next longer one in the constant ratio of 1:1.5 throughout each series. The eighth step in the same ratio is provided by so mounting the disc that a short length of the slit projects beyond its outer radius and thus receives continuous exposure. Each step is 2mm in radial height. In use, the disc is to be mounted directly in front of the slit and as close as possible to it so as to produce sharply defined breaks between successive steps in the photographed spectrum lines. Each line consists of a series of segments of decreasing density from one end to the other. Strong lines will have eight such steps; weaker ones will have insufficient exposure through the shorter steps to produce developable images on the photographic plate. Thus the length of the line, expressed as the number of detectable steps, provides an index to line intensity. Photometric measurements of all steps in a line together with the corresponding relative exposures, as determined by the known step ratios of the sector disc, permit the plotting of the characteristic density vs. log.-exposure curve of the photographic plate at the wave length of the line involved. From this curve it is then possible to reduce density ratios to light intensity ratios which are directly related to concentration.

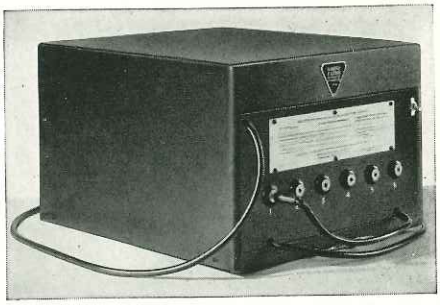
With the step sector, the plate calibration is carried out in the same spectrum and at the same wave lengths that are used for the analysis, thus avoiding errors that may be introduced when it is based on a separate spectrum taken from a different light source and on a different area of the emulsion.

Filters

For plate calibration work, as an alternative to the sector disc, a series of step filters is offered, to replace the standard crystalline quartz slit cover lens on the slit holders of Bausch & Lomb Spectrographs. Portions of the plano side of a standard quartz slit cover lens are filmed with inconel for the transmission listed. The other part is left clear (100% transmission). On the 3-step type the clear portion is in the center. The film transmission value may vary somewhat from the nominal value specified. Linearity of the film is excellent over the entire spectral range from 2000 to 7000A. Uniformity of density is also high over the area used over the slit, as no bubbles are permitted in a space 1mm wide across the center of the filmed area perpendicular to the dividing line.

Filters are unmounted for use in the Bausch & Lomb Fixed Slit Holder Assemblies, No. 33-84-13 and No. 33-84-18, described below.

Spark Generator



This consists of a 0.45 K. V. A. step-up transformer delivering high tension current at 15,000 volts from a 115 volts, 60 cycle alternating current supply. A condenser of 0.005 micro-farads is included to produce a heavy condensed spark of suitable character for simple spectrographic analysis. The electrical units have been chosen with care to withstand continuous use at full capacity, and their characteristics are such as to give the most satisfactory conditions for average analytical purposes. A self induction coil of suitable size to eliminate air lines from the spectrum is included. Its inductance is variable in five steps from 0 to 20 micro-henries.

Slit Assemblies

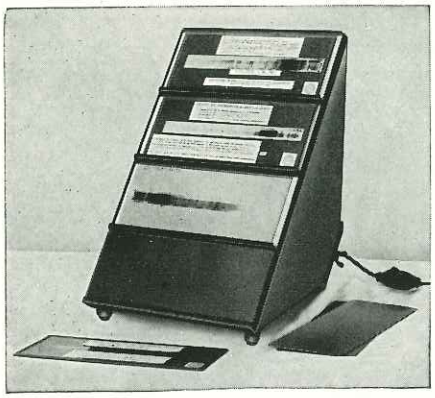
Both the adjustable and fixed slit types are now available. They are attached to the spectrograph by three screws. Users can replace one with the other. In addition to the model described on page 4, a fixed slit assembly, 33-84-18, is offered with provision for one lens only in a mount which can be rotated through an angle of 90°.

Fixed slit assembly, No. 33-84-18, is designed for holding a single com-

bination slit cover lens and filmed step filter as an alternative to the use of the mechanical step sector disc. The simple rotatable mount permits photographing through the clear portion only of the filter as well as across all the steps.

Fixed slits may be selected from the listing on page 5. Orders should indicate whether the standard quartz slit cover lens is desired. Filters available, made to purchaser's specifications.

Spectrum Plate Viewing Box



The B&L Spectrum Plate Viewing Box has been designed to permit the examination and display of spectrum negatives under conditions that will reveal every detail.

It consists of a sheet metal housing of pyramidal form with a 60W lamp at the apex. The inside surface of the housing is coated with a matte white paint which diffuses the light and insures even illumination of the observation windows. These windows, four in number, and 4″ x 10″ in size, form the base of the pyramid and are glazed with white milk glass, giving a beautifully even, grainless background against which the plates are placed. Under each window is a shallow metal slot which supports the plate.

Spectrum Measuring Magnifier

This 38mm, 6.5× glass is a great timesaver in the examination of spectrum plates. A ruled scale, 20-mm long, numbered and divided into tenths of a millimeter, permits measurements of moderate accuracy. Length of the magnifier is approximately two inches, diameter 1¼″.

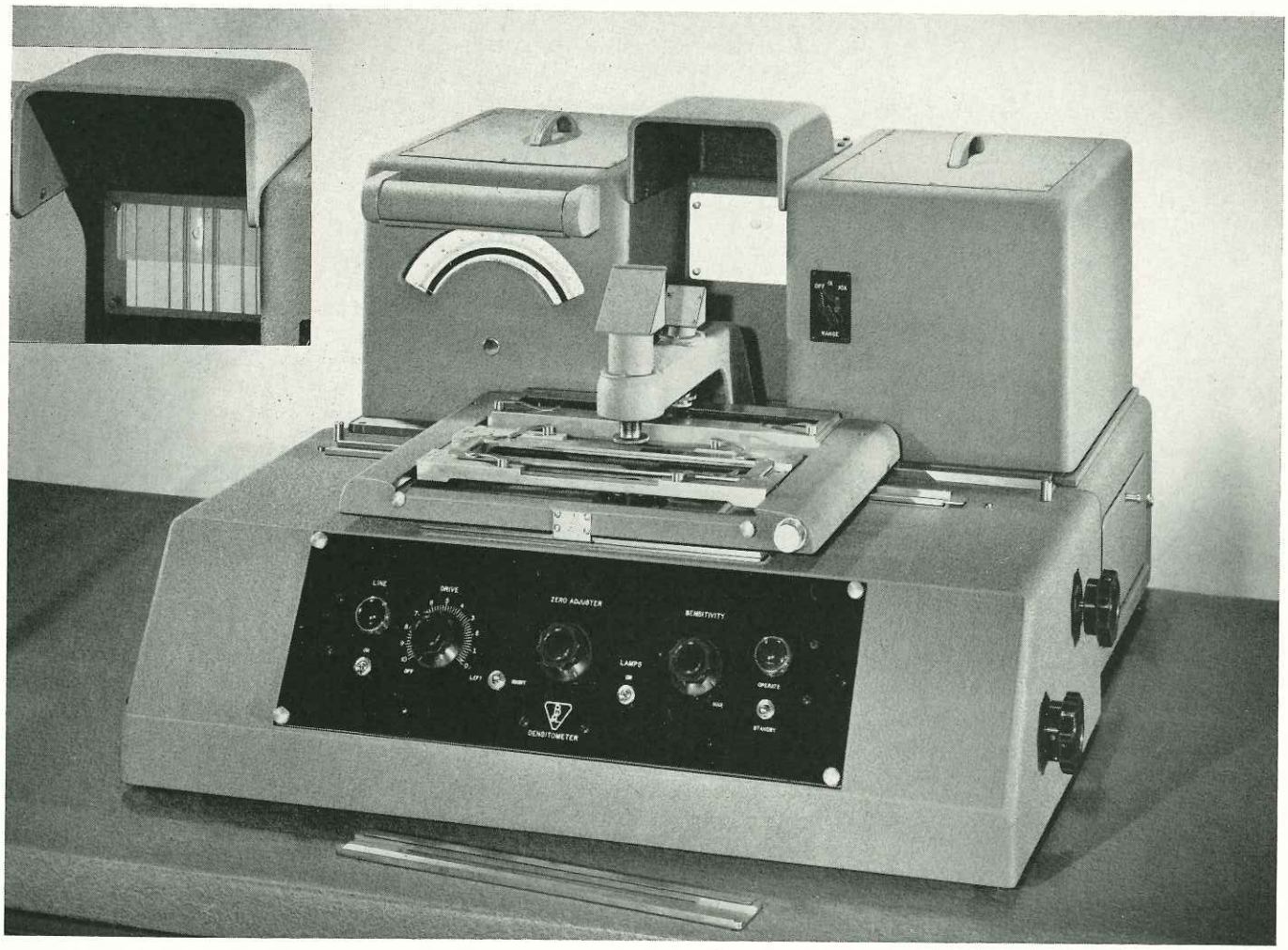
Specifications	*Catalog Number*	*Price*
Illuminating Units		
Illuminating Unit, with base for Littrow Spectrograph, Arc and Spark Stand No. 33-84-66, rheostat for 115-volts D.C., condensing lens assembly 33-84-28, sector mount with universal motor for 115-volts D.C. or A.C., and adjustable sector disc	33-84-49-03	
Illuminating Unit, same as 33-84-49-03, except with rheostat for 230-volts D.C.	33-84-49-13	
Safety Arc and Spark Illuminating Unit, with base for Littrow Spectrograph, Safety Arc and Spark Stand 33-84-39-01, rheostat for 115-volts D.C., sector mount with universal motor for 115-volts D.C. or A.C., and adjustable sector disc	33-84-49-05	
Safety Arc and Spark Illuminating Unit, same as 33-84-49-05, except with rheostat for 230-volts D.C.	33-84-49-15	
Basic Components for separate purchase		
Illuminating Base only, for Large Littrow Spectrograph	33-84-49	
Arc and Spark Stand, complete with eye shield	33-84-66	
Safety Arc and Spark Stand, complete	33-84-39-01	
Rheostat for Arc and Spark Stand for 115-volts with three point switch to permit approximately 2, 4, or 9 amperes	42-46-50	
Rheostat, same as above, but for 230-volts D.C.	42-46-51	
Sector Mount, with universal motor and rheostat (115-volt A.C. or D.C.) and clamp base	33-84-64-01	
Adjustable Sector Disc	33-84-59	
Quartz Condenser Assembly, complete with clamp base	33-84-28-01	
Clamp Base	33-84-38	
Accessories and Supplies		
Spectrum Viewing Box, for 115-volt A.C. or D.C.	33-84-70-11	
Spectrum Magnifier with mm scale for examining spectrum plates	81-34-97-20	
Spark Generator	33-84-62	
Logarithmic Step Sector Disc (interchangeable with 33-84-59)	33-84-58	
Fixed Slit Holder; with Hartmann Diaphragm; Multiple Lens Holder; Quartz Cover Lens,* 21mm diameter, 421mm E.F.; Leatherette Case for three fixed slits	33-84-13	
Fixed Slit Holder, same as 33-84-13, except with holder for single lens only in mount rotatable 90°; without cover lens; with slit storage case	33-84-18	
Fixed Slit, 10 micron, in plastic envelope	33-84-06	
Same, 20 micron	33-84-07	
Same, 30 micron	33-84-05	
Same, 50 micron	33-84-08	
Adjustable Slit Assembly, with Hartmann Diaphragm, and Quartz Cover Lens,* 21mm diameter, 421mm E.F. in simple mount	33-84-14	
Filter Lens, two step, quartz; 21mm diameter, 421mm E.F.; 100% and 10% transmission (nominal)	33-84-16	
Same, 100% and 35%	33-84-17	
Same, 100% and 65%	33-84-23	
Same, 3 step: 100%, 25% and 6%		
Replacement Parts		
Slit Cover Lens, quartz; 21mm diameter, 421mm E.F., unmounted, for 33-84-41-01 Littrow Spectrograph	338414-021	
Condenser Lens, quartz, for 33-84-28-01 and 33-84-39-01, 40mm diameter, 131.8mm E.F., unmounted	338439-021	
Rheostat for 33-84-64 Sector Mount	LR-92	
For 33-84-66 Arc and Spark Stand		
Electrode Holder only	33-84-65	
Insulator-Rack and Pinion Assembly, complete—		
Specify: Upper Assembly	26675-45	
Lower Assembly	26675-46	
Eyeshield, Blue Plastic, 7″ x 11″, without fittings		
For 33-84-39-01 Safety Arc and Spark Stand		
Electrode Holder-Insulator-Adapter Assembly, complete to attach to Rack and Pinion Assembly. Specify upper or lower, each		
Electrode Holder Assembly only to attach to Insulator. Specify upper or lower, each		
Insulator Assembly, only, with adapters to take Electrode Holder and Rack and Pinion Assemblies. Specify upper or lower, each	338439-138	
Rack and Pinion Assembly only	338439-168	
Condenser Lens, quartz; 40mm diameter, 131.8mm E.F.	338439-021	
Safety Switch	LS-39	

*If lens not wanted, specify on order. Credit allowed.

U. S. Patent Office
AUG 19 1955
Design Division

DENSITOMETER

Rapid Quantitative Spectrum Analysis



THE Bausch & Lomb Densitometer is a precise, projection type, photo-electric instrument for measuring the light transmitted by spectrum lines on photographic plates and films.

It is a sturdy, compact, self-contained unit requiring a minimum of space as an external galvanometer is not required. Freedom from extraneous light interference permits its use in daylight. Readings may be made directly from the built-in meter or records can be made by plugging in a standard electronic recorder. Projection of a comparison spectrum, a motor driven plate holder with variable speed, maintenance of operating temperature for intermittent work and grouping of controls at arm level are but a few of the features provided for speed and accuracy of determinations and comfort of the operator. Operation is from a 115V A.C.—60 cycle line.

The Densitometer is not affected by spark operation in the same room.

The Line Measuring System

Light from a 25-watt, 6-volt incandescent lamp is directed by two different paths to illuminate a selected area of the plate to be measured. By one path a system of condensing lenses focuses a sharp image of the filament in the plane of the emulsion surface of the spectrum plate which is held in a horizontal position in a movable plate holder. The lamp can be adjusted to bring the image into position so that, when it is projected onto the viewing screen, it will be accurately centered over the slit through which the light will pass to the photo-electric cell. The light intensity is stabilized by a voltage regulating transformer.

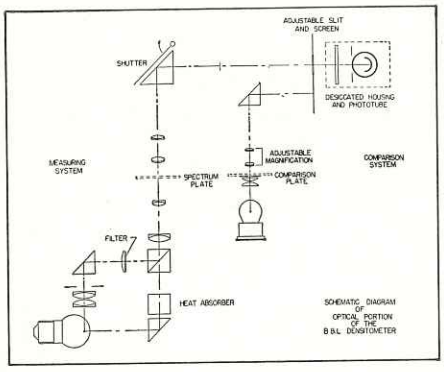
By the second path, another system of lenses receives light from the same lamp and illuminates, at reduced intensity, an extended area of the spectrum on both sides of the filament image. This permits visual observation of the neighboring regions of the spectrum and selection of the lines to be measured. An amber colored filter is placed in this light path so that the light that illuminates the extended field is of a wavelength that will not affect the photo-electric cell. Consequently, the only light that can be indicated

by the instrument is that from the direct, unfiltered image of the filament, transmitted through the spectrum line. Shields, suitably placed in the light path effectively prevent extraneous light from reaching the photo-electric tube. The Densitometer therefore, can be used in a lighted room.

Adjustable Photo-Cell Slit

A projection lens of high aperture and resolving power, in a focusing mount above the plate, projects an enlarged image of the entire illuminated area on a vertical white screen at eye level. In the middle of the screen is the slit that restricts the light passing to the photo cell to that which has passed through a spectrum line. The width of this slit can be adjusted according to the widths of spectrum lines on the plates to be measured. It has an effective length of 20 millimeters, which, with the 16× magnification produced by the projection lens, corresponds to a line length of 1.25 millimeters on the spectrum plate. Its width is adjustable from 0 to 2mm by means of two eccentric adjusting pins which move the jaws, sliding in accurately parallel gibs. The slit is mounted so that it can be rotated by means of a convenient knob through a sufficient angle in the plane of the projection screen to align it with the projected spectrum lines.

A removable projection screen is provided over the permanent screen with an aperture of 10mm diameter. It permits measurement of lines as short as 0.63mm and makes easier the setting of a line over the slit.



Unique Light Receptor Assures Accurate Readings

Behind the slit, in a sealed and desiccated chamber is a photo-electric tube, to receive the light transmitted by the spectrum line being measured. This type of tube is superior to a barrier layer cell in its freedom from effects of fatigue and temperature variation.

This provision for a thoroughly dry atmosphere about the phototube, battery and amplifier grid resistors is an important factor in insuring a stable condition of the meter.

Stable Amplifier—Direct Reading Meter

The amplifier is of the direct current bridge type, using standard radio tubes, obtainable for replacements from local radio dealers.

The output of the amplifier is indicated on a Weston Microammeter which reads directly in percent transmittance of the spectrum line or other area the image of which is projected on the slit. The scale reads from 0 to 100% and is divided in 1% units. Estimates can be made to 0.2% with the usual meter accuracy of ±0.5% applying. A dial on the control panel permits the setting of the meter zero when light is excluded from the photo-tube by a shutter on the reflecting prism of the projection system. A second dial serves to adjust the 100% reading for a clear plate or for any background area, adjacent to a spectrum line, that may be taken as the basis of comparison. The meter scale is at the same level and slightly to the left of the screen on which the spectrum is projected so that there is only a slight shift in the line of sight during a measurement.

For greater sensitivity in measuring lines of high density a "Range Switch," operated by an indicating knob on the front of the instrument, is provided. In the 1× position, the meter reads directly from 0 to 100% transmittance. With the switch in the 10× position the indications on the meter are ten times the actual transmittance values. Thus, a reading of 10% on the meter indicates a transmittance of 1%.

The readable density range is from 0 to 2 for the meter readings 100% and 1% with the 1× range. In the 10× range a reading of 1% represents a density of 3.

Use of the photo-electric tube, amplifier and microammeter provides a sturdier and more compact assembly than one depending on a high sensitivity galvanometer, requiring a vibration absorbing Julius Suspension and a long clear light path between the densitometer and the galvanometer.

Versatile Sample Holder—Plates or Film

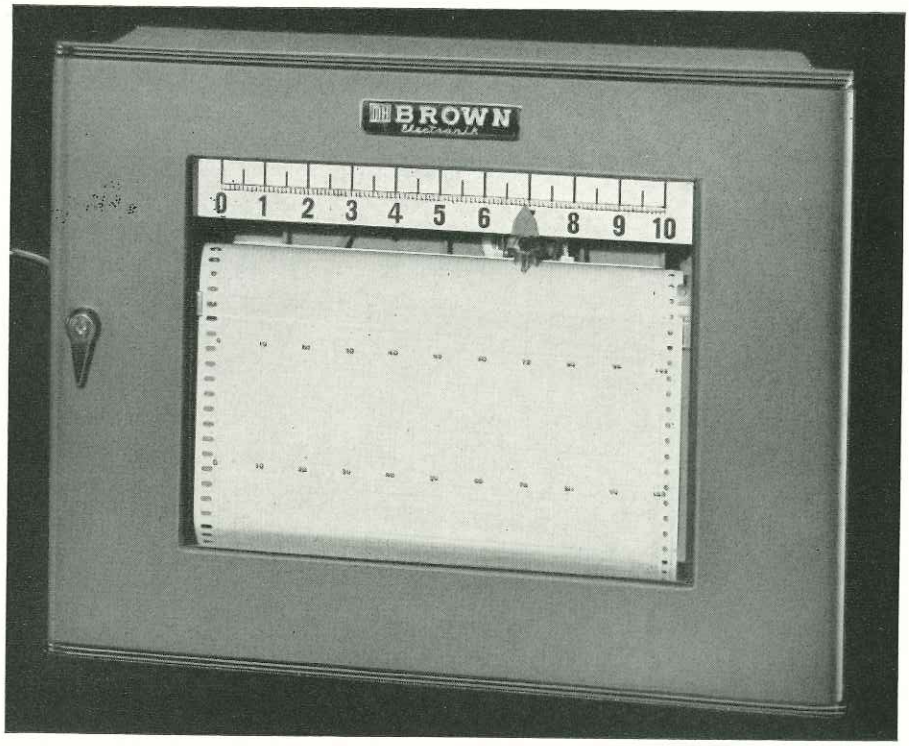
The plate to be measured is held in a horizontal plate holder by spring clips. An eccentric pin in contact with the edge of the plate near one end aids in aligning the spectrum with the direction of travel. The plate holder takes 4″ x 10″ plates with an adapter for 2″ x 10″ plates and is drilled to take the Echelle Plate Adapter 33-84-37. A film holder for 35mm strip film is provided, to fit into the plate holder.

Three-Way Drive

The plate holder is mounted on a heavy carriage that is movable on V-type ball bearing rollers through the full ten-inch length of the plate. This motion can be actuated in three different ways: (1) by hand; (2) by lead screw; (3) by variable speed electric motor.

The spectrum line to be measured is brought close to the slit with no intervening line. The motor drive is then started in the appropriate direction to cause the line to pass over the slit, during which time the observer needs only to watch the needle of the meter to know when the line is in proper position for the reading. The motor control switch has a graduated dial for duplicating speed settings. Maximum speed of plate travel is 1.4mm per minute.

A manually operated crosswise motion is also provided for bringing different spectra quickly into line for measurement. Slow motion adjustment is made by a screw with a knurled knob.



Electronic Recorder

The Comparison System

For projecting a comparison spectrum from another plate than the one being measured a second illuminating and projecting system is provided. The comparison plate is held on a plate holder directly back of the one for the analytical plate, and mounted on the same carriage so that the two plates move together. It is illuminated from below by a system similar to that which illuminates the extended area of the analytical plate. This area is projected onto the lower half of the screen directly below the analytical spectrum. The projection lens is of the variable magnification type and can be adjusted to give the same magnification of the comparison spectrum as prevails in the analytical spectrum even though there are small differences between the two plates. In this way, it is easily possible to bring lines common to the two spectra into register.

Specifications	*Catalog Number*	
Densitometer, for 120-volt, 60 cycle A.C., complete with voltage regulator, holder for 4″ x 10″ plate, adapter for 2″ x 10″ plates and holder for 35mm film (12″ long), and cord with jack plug for connecting with Recorder 32-84-74	33-84-91-01	
*Recorder Brown Electronik adjusted for use with Densitometer, for 120-volt, 60-cycle A.C., complete with change speed gears, roll chart paper	33-84-74	
Adapter for 4″ x 10″ Echelle Plates	33-84-37	
Replacement Parts		
Lamp, 25-watt, 6-volt, for analytical plate beam	42-42-23	
Lamp, 2.75 amps., 6.5-volt, for comparison plate beam	31-31-39	
Lamp, for panel board	33-33-52	
Fluorescent Lamp, 4-watt, for meter	31-31-03	
Tubes obtainable locally, see instruction manual for part numbers.		
*If a Recorder other than this standard unit is to be used with the Densitometer, it should be shipped to us, transportation charges prepaid, for modification and adjustment at extra charge.		

If measurements of line separations are desired as a means for determining wavelengths and for identifying lines in the projected spectrum, an accurately ruled transparent scale can be mounted on the comparison plate holder and projected on the screen directly below the spectrum to be measured. The scale of the Bausch & Lomb No. 81-34-97-20 Measuring Magnifier can be used effectively for this purpose if desired.

Automatic Recording Facility

The non-recording Bausch & Lomb Densitometer is generally preferred for routine process control analysis. However, if the work to be done is such that an automatic record of the measurements is required, it is not necessary to purchase a complete separate recording densitometer. The Bausch & Lomb Densitometer is arranged so that it can be electrically connected with one of the well-known commercial forms of electronic recorders, by the simple insertion of a standard telephone plug into a jack in the right side of the base, after modification.

For this purpose, the Brown single Record High Speed Electronik Strip Chart Potentiometer is available at extra cost, under B&L Catalog No. 33-84-74. Records are produced of the variations in opacity of successive lines along the length of the spectrum plate, or film, as an ink line on a paper chart, twelve inches wide.

These records reveal with marked clarity and precision lines which are hardly detectible by visual examination and having almost imperceptible details of line contour. The way in which they repeat such details with successive surveys can be appreciated only by critical comparison with the original spectrum plates.

Specifications

Overall Size and Weight:
Densitometer—31″ x 30″; 365 lbs.
Recorder—20″ x 14″ x 14″; 100 lbs.

Reference:

"A New Deflection Type Densitometer," W. G. Kirchgessner, The Review of Scientific Instruments, Vol. 22, No. 5, 289-292, May 1951.

ELECTRODE SHAPER

Rapid, accurate shaping of carbon electrodes

U.S. Patent Office
AUG 19
Design Division

FOR forming the ends of graphite rods intended to be used as electrodes for arc and spark excitation sources, this Bausch & Lomb Electrode Shaper is simple, quick, versatile, and accurate. Essentially, it is a small turret lathe—the electrodes being held in a Jacobs chuck, and revolved by an electric motor against a set of cutters and a drill.

Four pairs of adjustable cutters, each having two cutting edges, hollow ground on one side and beveled on the other, are mounted in the turret head. Three of the cutter pairs have drills mounted between the blades, while the fourth station mounts a special cutting tool. The cutters can be adjusted to shape the exterior and ends of the electrodes to the desired form, while the drills* form the central cavity. At the fourth station, instead of a drill there is a special cutting tool which forms a central post within an annular cavity. The turret head is easily rotated to bring the desired shaping combination into position.

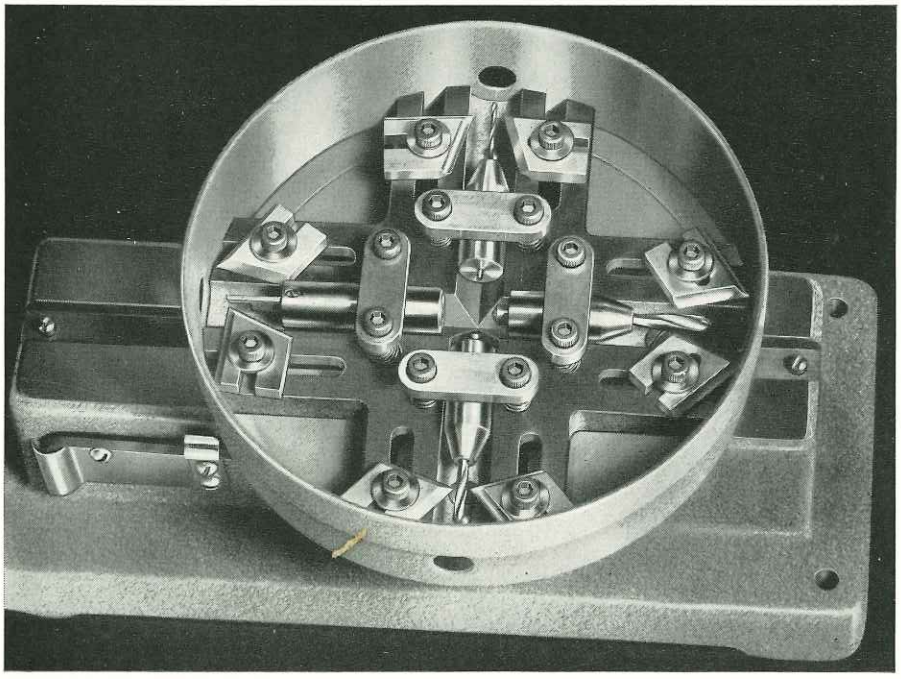
The motor, with braking disc and chuck, is securely mounted to the bed and plugs into any 115-volt, A.C., 60-cycle circuit.

Operation of the Shaper is extremely fast and simple. After the proper group of shaping tools has been put into position and the graphite rod is inserted in the chuck, movement of the turret along the channeled base automatically energizes the motor circuit, releases the brake, and brings the electrode in contact with the cutters. The electrode is almost instantly shaped, after which reverse movement of the turret de-energizes the motor circuit, and applies the brake which stops the motor's "coasting."

Finish is grey wrinkle and the turret has a transparent cover, enabling the operator to check the cutters and drills. Further, the cover keeps the graphite dust in the turret and, also, keeps dirt out. This dust can then be removed and used in the making of briquetted samples of non-conductors.

*Drill Sizes: 1/16", 1/8", 3/16"

Electrode Shaper



The turret head with transparent cover removed. Drills are 1/16", 1/8" and 3/16" diameter. Post cutting tool in operating position can be adjusted laterally for desired post diameter.

Size: 19" x 6" x 5¾" Weight—24 lbs. net.

Specifications	*Catalog No.*	
Electrode Shaper with four shaping assemblies and motor for 115-volt A.C., 60 cycle	33-84-09	
Replacement Cutters, set of 8 cutters		

SPECTROGRAPHIC OUTFITS

To guide the purchaser in the selection of essential equipment, the following outfits are suggested

		Arc Only 115-V, D.C.	*Arc Only 230-V, D.C.*	*Spark Only A.C.*	*Arc 115-V, D.C. Spark A.C.*	*Arc 230-V, D.C. Spark A.C.*
LITTROW SPECTROGRAPH With Arc and Spark Stand No. 33-84-66	Outfit	4-a	4-b	4-c	4-d	4-e
For general emission analysis, including equipment adequate for complex spectra such as those of iron and steel, the rare earths, etc.	33-84-40-01	1	1	1	1	1
	33-84-49-03	1	—	1†	1	—
	33-84-49-13	—	1	—	—	1
	33-84-58	1	1	1	1	1
	33-84-61	100	100	100	100	100
	33-84-62	—	—	1	1	1
	33-84-63	2	2	2	2	2
	33-84-70-11	1	1	1	1	1
	81-34-97-20	1	1	1	1	1
LITTROW SPECTROGRAPH With Safety Arc and Spark Stand No. 33-84-39	Outfit	4-as	4-bs	4-cs	4-ds	4-es
For general emission analysis, including equipment adequate for complex spectra such as those of iron and steel, the rare earths, etc.	33-84-40-01	1	1	1	1	1
	33-84-49-05	1	—	1†	1	—
	33-84-49-15	—	1	—	—	1
	33-84-58	1	1	1	1	1
	33-84-61	100	100	100	100	100
	33-84-62	—	—	1	1	1
	33-84-63	2	2	2	2	2
	33-84-70-11	1	1	1	1	1
	81-34-97-20	1	1	1	1	1

†Outfit includes an Illuminating Unit like 33-84-49-03 or -05 but without Rheostat.

Motors used in Sector Mounts of Illuminating Units are 115-V, Universal. If 115-V, A.C. or D.C. is not available, a suitable resistor or transformer should be used in series with the motor.

For a more complete Spectrographic Laboratory, select additional accessories from Pages 10—13.

TERMS AND PROCEDURE

CATALOG NUMBERS

When ordering, be sure to give catalog number and name of item.

FINANCIAL STANDING

To avoid delay, a purchaser with whom Bausch & Lomb has not previously transacted business should accompany his first order with commercial references or remittance in cash.

TRANSPORTATION CHARGES

Unless otherwise stated on a B&L quotation, all consumer purchases, except repairs, will be shipped transportation charges prepaid to any point within Continental United States of America. Other-than-consumer purchases, all repairs, and goods for delivery outside the above specified area will be shipped f.o.b. Rochester, N. Y., U. S. A. The shipping charges on products sent on memorandum are not prepaid. There is no charge for packing, unless otherwise stated. Products made on special order cannot be forwarded C. O. D.

SHORTAGE OR DAMAGE

To avoid error, Bausch & Lomb exercises the utmost care in checking and packing all shipments. All packing should be carefully examined for small items. If a discrepancy is found, report it to Bausch & Lomb immediately. Report to the transportation company at once any claim for loss, damage or breakage. Carriers are responsible for loss or damage to goods in transit. When shipping container shows damage, do not give a clear receipt, but sign for "in bad order." Save the container and obtain an inspection report from the carrier.

RETURNING GOODS

If it is desired to return goods, first send Bausch & Lomb full information by letter. Goods should not be returned for any reason until approval for their return has been received from Bausch & Lomb. Each item should be plainly tagged with sender's name and address. Identification tags will be sent on request.

ELECTRICAL EQUIPMENTS

Electrical equipments for use on voltages other than those listed are available on special order. Send complete specifications for quotations.

INQUIRIES

When writing, please give the date of your order, the Bausch & Lomb order number which appears on the packing slip and, if possible, the Bausch & Lomb invoice number.

PRICES

Prices are subject to change without notice. Orders are subject to acceptance at Rochester, N. Y., U. S. A., at prices prevailing at time of shipment. Orders for standard items may be cancelled if not wanted because of price advance. Excise taxes or other governmental charges will be added wherever applicable. Shipments to points outside Continental United States of America and to its territories, dependencies and possessions, except Hawaii and Alaska, are not subject to excise taxes. Delivery dates are estimated and cannot be guaranteed.

DESIGN CHANGES

Bausch & Lomb reserves the right to make changes in instrument design in accordance with scientific progress, and to supply apparatus resultingly different from that described or illustrated in its literature.

BAUSCH & LOMB OPTICAL CO.

Rochester 2, New York, U. S. A.

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CHICAGO, ILLINOIS.....Bausch & Lomb Optical Co., 18 South Michigan Avenue
SAN FRANCISCO, CALIFORNIA...Bausch & Lomb Optical Co., 20 Jones Street
MONTREAL, QUEBEC, CANADA...Bausch & Lomb Optical Co., Ltd., 1449 St. Alexander Street
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LONDON, ENGLAND.....Bausch & Lomb Optical Co., Ltd., Africa House, Kingsway, W. C. 2
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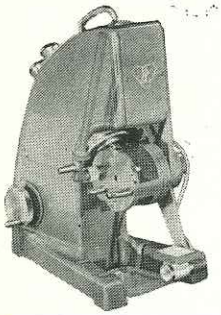
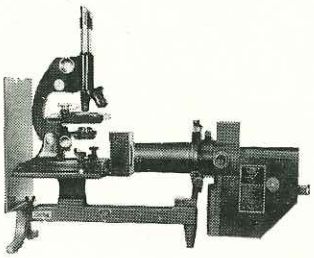
ADDITIONAL OPTICAL EQUIPMENT

The instruments described in this catalog are part of the complete line of optical instruments produced by Bausch & Lomb. A few others are shown below. Catalogs describing these top quality "tools of science" will be sent you on request.



REFRACTOMETERS

Models for every need—from hand to precision—for determination of the refractive index of liquids and solids



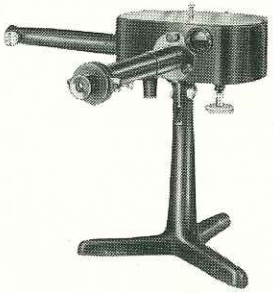
MICRO-PROJECTION EQUIPMENT

Wide range of types to answer the needs of a diversity of users in education, and general laboratory work.

U.S. Patent Office
AUG 19 1955
Design Division

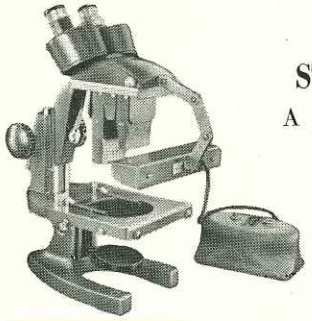
RESEARCH MICROSCOPES

A most complete group of the finest research instruments built to give years of satisfactory performance.



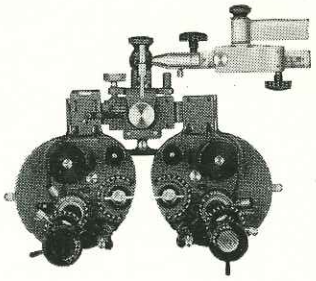
SPECTROMETERS

Uniquely constructed to assure constant deviation, these high quality instruments meet the most exacting needs of the laboratory.



STEREOMICROSCOPES

A complete line of Wide Field instruments, featuring dustproof prism housings, improved optical elements.

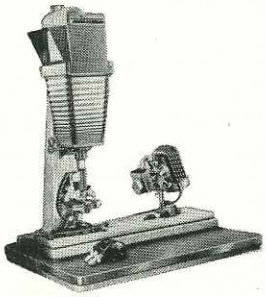


OPHTHALMIC INSTRUMENTS

B&L provides a complete line of instruments and equipment for eyesight examination.

PARA-PLANE GAGES

Rugged, long-lived instruments capable of highly precise determination of flatness and parallelism of reflecting surfaces.



PHOTOMICROGRAPHIC EQUIPMENT

A variety of Cameras for satisfactory use in both transmitted and reflected light microscopy from routine to the research level.

BAUSCH & LOMB OPTICAL CO.

Rochester 2, New York, U. S. A.

D-20, 5, XI-54

PRINTED IN U. S. A.

PRICE LIST FOR CATALOG D-20
SPECTROGRAPHIC EQUIPMENT

NOVEMBER 30, 1954

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BAUSCH & LOMB OPTICAL CO.

ROCHESTER 2, NEW YORK, U. S. A.

Catalog No.	*Price*
31-31-03	MCP $ 1.05 Tax .0525
31-31-39	MCP 1.90 Tax .027
33-33-52	MCP .23 Tax .0115
33-33-89	MCP .15 Tax .0048
33-84-05	80.00
33-84-06	80.00
33-84-07	80.00
33-84-08	80.00
33-84-09	220.00
33-84-13	235.00
33-84-14	525.00
33-84-16	60.00
33-84-17	60.00
33-84-18	160.00
33-84-23	60.00
33-84-28-01	80.00
33-84-37	75.00
33-84-38	25.00
33-84-39-01	650.00
33-84-40-01	7250.00
33-84-41-01	2250.00
33-84-44	200.00
33-84-46	200.00
33-84-49	236.00
33-84-49-03	775.00
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33-84-63	(ea.) 1.40
33-84-64-01	80.00
33-84-65	7.00
33-84-66	275.00
33-84-70-11	45.00
††33-84-74	net 662.00
33-84-91	6000.00
42-42-23	MCP 1.25 Tax .0625
42-46-50	38.00
42-46-51	52.00
81-34-97-20	†20.00

†Quantity Discount for 5 or more—10%.

††Charge for Adjusting Customer's Recorder for use with Densitometer net $20.00.

(over)

COMPLETE SPECTROGRAPHIC OUTFITS

with Quantities of Individual Components

LITTROW SPECTROGRAPH
With Arc and Spark Stand No. 33-84-66

	Arc Only 115-V, D.C.	*Arc Only 230-V, D.C.*	*Spark Only A.C.*	*Arc 115-V, D.C. Spark A.C.*	*Arc 230-V, D.C. Spark A.C.*
Outfit	4-a	4-b	4-c	4-d	4-e
Price	$8142.80	$8156.80	$8639.80	$8677.80	$8691.80
33-84-40-01	1	1	1	1	1
33-84-49-03	1	—	1*	1	—
33-84-49-13	—	1	—	—	1
33-84-58	1	1	1	1	1
33-84-61	100	100	100	100	100
33-84-62	—	—	1	1	1
33-84-63	2	2	2	2	2
33-84-70-11	1	1	1	1	1
81-34-97-20	1	1	1	1	1

LITTROW SPECTROGRAPH
With Safety Arc and Spark Stand No. 33-84-39

	Arc Only 115-V, D.C.	*Arc Only 230-V, D.C.*	*Spark Only A.C.*	*Arc 115-V, D.C. Spark A.C.*	*Arc 230-V, D.C. Spark A.C.*
Outfit	4-as	4-bs	4-cs	4-ds	4-es
Price	$8439.80	$8451.80	$8936.80	$8972.80	$8986.80
33-84-40-01	1	1	1	1	1
33-84-49-05	1	—	1*	1	—
33-84-49-15	—	1	—	—	1
33-84-58	1	1	1	1	1
33-84-61	100	100	100	100	100
33-84-62	—	—	1	1	1
33-84-63	2	2	2	2	2
33-84-70-11	1	1	1	1	1
81-34-97-20	1	1	1	1	1

*Outfit includes an Illuminating Unit like 33-84-49-03 or 33-84-49-05 but without Rheostat.

Glass Optical System not included in listed prices of outfits. It can be supplied with any No. 4 Outfit at the listed price of $2250.00.

Motors used in Sector Mounts of Illuminating Units are 115-V, Universal. If 115-V A.C. or D.C. is not available, a suitable resistor or transformer should be used in series with the motor.

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Printed in U.S.A.

Specifications	*Catalog Number*	*Price*
Page 5		
Scale Negative	27676-9001ND	$ 4.00
Page 9		
Accessories and Supplies		
Filter Lens, three step, quartz; 21mm diameter, 421mm E. F., 100%, 25% and 6% transmission (nominal)		70.00
Replacement Parts		
Slit Cover Lens, quartz; 21mm diameter, 421mm E.F., unmounted, for 33-84-41-01 Littrow Spectrograph	338414-021	45.00
Condenser Lens, quartz, for 33-84-28-01 and 33-84-39-01, 40mm diameter, 131.8mm E.F., unmounted	338439-021	45.00
Rheostat for 33-84-64 Sector Mount	LR-92	2.00
For 33-84-66 Arc and Spark Stand		
Electrode Holder only	33-84-65	7.00
Insulator-Rack and Pinion Assembly, complete—		
Specify: Upper Assembly	26675-45	55.00
Lower Assembly	26675-46	55.00
Eyeshield, Blue Plastic, 7″ x 11″, without fittings		3.50
For 33-84-39-01 Safety Arc and Spark Stand		
Electrode Holder-Insulator-Adapter Assembly, complete to attach to Rack and Pinion Assembly. Specify upper or lower, each		84.00
Electrode Holder Assembly only to attach to Insulator. Specify upper or lower, each		45.00
Insulator Assembly, only, with adapters to take Electrode Holder and Rack and Pinion Assemblies. Specify upper or lower, each	338439-138	39.00
Rack and Pinion Assembly only	338439-168	37.00
Condenser Lens, quartz; 40mm diameter, 131.8mm E.F.	338439-021	45.00
Safety Switch	LS-39	7.00
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Replacement Cutters for 33-84-09—set of 8		40.00